Syllabus
for
B.Sc. II (Physics)
Implemented from
June, 2019

1. Structure of Syllabus:

B.Sc. – II **Semester –III**

Paper Title	Theory			Practical		
	Paper Code	Lectures Per week	Credits	Paper Code	Lectures per week	Credits
Heat and Thermal Physics	BPT301	3	2	BPP303	8	4
Waves, Oscillations and Sound	BPT302	3	2			

B.Sc. – II **Semester –IV**

Paper Title	Theory			Practical		
	Paper Code	Lectures Per week	Credits	Paper Code	Lectures Per week	Credits
Thermal Physics and Statistical Mechanics	BPT401	3	2	BPP403	8	4
Optics and Lasers	BPT402	3	2			

Note: B: B. Sc. T=Theory and P= Practical

2. Titles of papers

B.Sc. – II Semester – III

Theory: 45 lectures, 36 hours (for each paper)

BPT301: Heat and Thermal Physics

BPT302: Waves, Oscillations and Sound

Practical: 80 lectures, 64 hours

BPP303: Heat, Thermal Physics, Waves, Oscillations and Sound

B.Sc. – II Semester – IV

Theory: 45 lectures, 36 hours (for each paper)

BPT401: Thermal Physics and Statistical Mechanics

BPT402: Optics and Lasers

Practical: 80 lectures, 64 hours

BPP403: Thermal Physics, Statistical Mechanics, Optics and Lasers

B. Sc.–II Semester – III

BPT301: Heat and Thermal Physics (Credits:2)

Course Objectives: Students should :

1. understand kinetic interpretation of temperature, Andrew's Expt. and different types of thermometers.
2. study kinetic theory of gases and concept of Transport phenomena.

3. understand thermo-dynamical state, thermodynamic equilibrium, various thermodynamic processes and first law of thermodynamics.
4. study second and third law of thermodynamics, Carnot's theorem, working of Carnot's engine, otto engine and diesel engine and concept of entropy.

Unit –I: Ideal, Real gas and Thermometry **11**

Kinetic Interpretation of temperature, Andrew's experiment and curve, critical constants, Relation between critical constants and Van der waal's constants, Reduced equation of state. Principle of thermometry, types of thermometers, Scales of temperature (Celsius, Kelvin, Fahrenheit and Rankine), Mercury thermometer, Thermoelectric thermometer, Platinum resistance thermometer, Thermister.

Unit- II: Kinetic Theory of gases and Transport Phenomena **11**

Review, Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path, Transport phenomena-Transport of momentum(viscosity), Transport of thermal energy (conduction), Transport of mass (diffusion), Degrees of freedom, Law of equipartition of energy (No derivation) and its application to specific heat of gases (mono and diatomic).

Unit-III: Thermodynamics-I **11**

Thermodynamic system, Thermodynamic variables, Thermodynamic state, equation of state, Thermodynamic equilibrium, Zeroth law of thermodynamics, Internal energy, First law of thermodynamics, Conversion of heat into work, Various thermodynamic processes (Isothermal, Adiabatic, Isobaric, Isochoric), Reversible and irreversible processes, Work done in Isothermal and adiabatic processes, Application of first law (Isothermal, Adiabatic, Isobaric, Isochoric), Relation between C_p and C_v.

Unit-IV: Thermodynamics-II **12**

Second law of thermodynamics (Explanation and different statements), Carnot's ideal heat engine, Carnot cycle (working and efficiency), Carnot's theorem, Entropy (concept and significance), Entropy changes in reversible and irreversible processes, Entropy – Temperature diagram, Third law of thermodynamics, Heat Engines in practice, Rankine cycle, Steam Engine, Internal Combustion Engine a) Otto Engine b) Diesel Engine.

Course Outcomes:

Unit –I: After completion of the unit, Students are able to:

1. explain kinetic interpretation of temperature,

2. understand Andrew's expt., Curve and different types of thermometers.

Unit –II: After completion of the unit, Students are able to:

1. explain kinetic theory of gases
2. define concept of Transport phenomena

Unit –III: After completion of the unit, Students are able to:

1. explain thermo-dynamical state
2. understand thermodynamic equilibrium, various thermodynamic processes and first law of thermodynamics.

Unit –IV: After completion of the unit, Students are able to:

1. explain second and third laws of thermodynamics
2. explain Carnot's theorem and working of Carnot's engine, otto engine and diesel engine and concept of entropy.

REFERENCE BOOKS:

1) Heat and Thermodynamics, Brijlal and N. Subramanyam, S.Chand and Company Ltd. Publisher, 2001.
2) Heat and Thermodynamics, D. S. Mathur, S. Chand and Sons Ltd. Publisher, 2008.
3) Text book of Heat and Thermodynamics, J. B. Rajam and C. L. Arora, S. Chand and Company Ltd Publisher, 9th edition, 1981.
4) A treatise on Heat, Meghnad Saha and B.N. Srivastava, Indian Press Ltd., 2nd edition 1935.
5) Heat and Thermodynamics, M.W. Zemansky and R. Dittman, Tata McGraw-Hill Education Pvt. Ltd., 8th edition, 2011.
6) Heat Thermodynamics and Statistical Physics, J. P. Agrawal and Satya Prakash, Pragati Prakashan, 2018.

BPT302: Waves, Oscillations and Sound (Credits:2)

Course Objectives: Students should

1. understand SHM and its solution, superposition principle and Lissajous figures and their uses.
2. study travelling and standing waves on a string, plane waves and spherical waves.
3. study transducers and their types, to understand concept of acoustics of buildings, Sabine's experimental work and reverberation time.

4. understand the Piezo-electric effect, detection of Ultrasonic waves and applications of Ultrasonic waves.

Unit-I: Oscillations **11**

Simple harmonic motion, Differential equation of SHM and its solutions, Kinetic and potential energy, Kater's pendulum, Damped oscillations,

Superposition of two collinear harmonic Oscillations:

Linearity and superposition principle

1) Oscillations having equal frequencies along the line and 2) Oscillations having different frequencies along the same straight line (beats), Lissajous figures with equal and unequal frequencies and their uses

Unit-II: Wave motion **11**

Transverse waves on a string, travelling and standing waves on a string, normal modes of a string, Laws of vibration, Energy density and energy transport of transverse wave along a stretched string group velocity, phase velocity, plane waves and relation between them, spherical waves, intensity of a wave

Unit-III: Sound **11**

Acoustics Transducers (Qualitative), pressure microphone, moving coil loud speaker, Digital audio system.

Acoustics of Buildings :

Reverberation time, factors affecting acoustics of buildings, Sabine's experimental work and formula, optimum reverberation time, Requirements of good acoustics.

Unit-IV: Ultrasonic Waves : **12**

Piezo-electric effect, Magnetostriction effect, production of ultrasonic waves- magnetostriction oscillator, Piezo-electric oscillator, detection of ultrasonic waves- Kundt's tube, sensitive flame method, thermal detector, quartz crystal method, Magnetostrictive method, applications of ultrasonic waves- medical field, SONAR, chemical field, cracks in metals, formation of alloy, sterilization, enemy of lower life.

Course Outcomes:

Unit –I: After completion of the unit, Students are able to:

1. understand the SHM and its solution
2. understand superposition principle, Lissajous figures and their uses

Unit –II: After completion of the unit, **Students are able to:**
1. understand travelling and standing waves on a string
2. understand plane waves, spherical waves

Unit –III: After completion of the unit, **Students are able to:**
1. explain transducers and their types,
2. understand concept of acoustics of buildings, Sabine's experiment and reverberation time

Unit –IV: After completion of the unit, **Students are able to:**
1. understand the Piezo-electric effect
2. explain detection of ultrasonic waves and their applications.

REFERENCE BOOKS:
1. Fundamentals of Physics Volume 1 C, Halliday and Resnick, Wiley Publisher, 9th edition, 2011.
2. A text book of Sound, Subrahmanyam and Brijlal, S. Chand Publisher, 2nd edition, 2018.
3. Elements of properties of matter, D. S. Mathur. S. Chand and Co Ltd. Publisher,2010.
4. Textbook of Sound, D. R. Khanna and R. S. Bedi, Atma Ram and Sons Publisher, 1971.
5. A Treatise on oscillations, waves and acoustics, D. Chattopadhyay, Books and allied Pvt. Ltd. Publisher, 2016.
6. Principles of Physics, J. Walker, David Halliday and Robert Resnick Wiley Publisher. 10th edition, 2014.
7. Oscillations and Waves, Satya Prakash, Pragati Prakashan, 2017.

BPP 303: Thermal Physics, Waves, Oscillations and Sound

Practical: 80 lectures, 64 hours **(Credits: 02)**

Course Objectives: Students should:
1. learn measuring skills in practical.
2. understand period of oscillations, frequency of a wave and acceleration due to gravity.
3. understand the length of vibrating air columns, Resonance and can measure velocity of sound.
4. learn thermal conductivity, temperature coefficient of resistance and specific heat.

Experiments:

Group - A

1. To determine Coefficient of Thermal Conductivity of a bad conductor by Lees method.
2. To determine Coefficient of Thermal Conductivity of copper by Searle's apparatus.
3. To study the variation of thermo-emf with temperature across two junctions of a thermocouple.
4. To determine temperature coefficient of resistance by platinum resistance thermometer.
5. To determine temperature coefficient of resistance of a given coil by P. O. box.
6. To calibrate Resistance Temperature Device (RTD) using null method / off-balance bridge.
7. To determine the thermal conductivity of a metal rod by Forbe's method.
8. To determine Coefficient of Thermal Conductivity of glass in the form of a tube.
9. To determine the specific heat of a liquid (turpentine oil) by law of cooling.
10. To determine the ratio of specific heat of air by Clement and Desorme's method.
11. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.

Group - B

1. To investigate the motion of coupled oscillations.
2. To determine acceleration due to gravity by using Bifilar Pendulum.
3. To study Lissajous figures.
4. Measurement of velocity of sound by Kundt's tube method.
5. Measurement of Velocity of Sound by CRO.
6. Measurement of Velocity of Sound by Resonating Bottle.
7. Measurement of frequency of tuning fork by Melde's Experiment.
8. Measurement of log decrement by Exponential Decay.
9. Measurement of Velocity of Sound by Sonometer.
10. To determine the frequency of Crystal oscillator.
11. To determine the frequency of A.C. mains by Stroboscope.

Course Outcomes:

Group A- after completion, students are able to:

1. learn measuring skills in practical
2. determine thermal conductivity and temperature coefficient of resistance
3. understand thermo-emf and specific heat

Group B- after completion, students are able to:

1. measure period of oscillations
2. measure frequency of a wave

3. understand the concept of acceleration due to gravity
4. measure the length of vibrating air columns and velocity of sound.

REFERENCE BOOKS :

1. Advanced Practical Physics for Students, B. L. Worsnop and H. T. Flint, Asia Publication House, 1971.
2. Practical Physics, S. L. Gupta and V. Kumar, Pragati Prakashan, 27th edition, 2010.
3. An Advanced course in Practical Physics, D. Chattopadhyay and P. C. Rakshit, New Central Book Agency Pvt. Ltd. 7th edition, 2005.
4. Experimental College Physics, White and Manning, McGraw-Hill Book Company. 3rd edition,1954.
5. B.Sc. Practical Physics, H. Singh and P. S. Hemne, S. Chand Publication, 4th edition, 2011.
6. B.Sc. Practical Physics, C. L. Arora, S. Chand Publication, 1957.

B. Sc. –II Semester – IV

BPT-401: Thermal Physics and Statistical Mechanics (Credits: 2)

Course Objectives: Students should:

1. understand various thermo dynamical functions, Maxwell's Relations, Joule –Thompson effect and Clausius- Clapeyron Equation.
2. understand Black body radiation, Planck's law, Rayleigh-Jean's law, Stefan Boltzmann law and Wien's displacement law.
3. understand Phase Space, Macrostate, Microstate, Ensembles, Priori Probability.
4. understand thermodynamic Probability and Maxwell Boltzmann Distribution law.

Unit –I Thermodynamic Potential 12

Enthalpy, Gibbs function, Helmholtz and Internal Energy function, Maxwell's Relations and applications, Joule –Thompson effect, Clausius- Clapeyron Equation, Expressions for $(C_p - C_v)$ and C_p / C_v, TDS equation.

Unit-II Theory of Radiation 11

Black body radiation, Spectral Distribution, Experimental Study of black body radiation Spectrum, Concept of energy density, radiation Pressure, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jean's law, Stefan Boltzmann law and Wien's displacement law from Planck's law

Unit-III Basics of Statistical Mechanics. **11**

Phase Space , Macrostate and Microstate, Ensembles, Accessible Microstate, Priori Probability, Thermodynamic probability.

Unit-IV Classical Statistical Mechanics **11**

Fundamental postulates of statistical mechanics, Probability distribution, Maxwell Boltzmann Distribution law (Evaluation of constants α and β)), Entropy and Thermodynamic Probability, Maxwell distribution of molecular speed.

Course Outcomes:

Unit –I: After completion of the unit, Students are able to:

1. explain thermo dynamical functions,
2. understand Maxwell's relations, Joule-Thompson effect and Clausius- Clapeyron equation.

Unit –II: After completion of the unit, Students are able to:

1. explain Black body radiation and Planck's law
2. explain Rayleigh-Jean's law, Stefan Boltzmann law and Wien's displacement law.

Unit –III: After completion of the unit, Students are able to:

1. explain phase space
2. understand macrostate, microstate, Ensembles, Priori and thermodynamic Probabilities.

Unit –IV: After completion of the unit, Students are able to:

1. understand Maxwell Boltzmann distribution law.
2. explain Entropy and thermodynamic probability

Reference Books:

1. Thermodynamics and Statistical Physics, S. S. Singhal, J. P. Agrawal, Satya Prakash Pragati Prakashan, 2017.
2. Heat and Thermodynamics, Brij Lal and N. Subramanyam, S. Chand and Company Ltd. Publisher, 2007.
3. Heat and Thermodynamics, M.W. Zermansky and R. H. Dittman, Tata McGraw-Hill Education Pvt. Ltd., 8th edition, 2011.
4. Thermal Physics, B. S. Agrawal, Kedar Nath Ram Nath Publisher, 2017.
5. Heat and Thermodynamics, J. B. Rajam and C. L. Arora, S. Chand and Company Ltd. 9th edition, 1981.
6. A Treatise on Heat, M. N. Saha and B. N. Srivastava, Indian Press Pvt. Ltd. 3rd edition, 1950.

7. Thermodynamics Kinetic Theory and Statistical Thermodynamics, F.W. Sears and G. L. Salinger, Narosa Publishing House, 3rd edition, 1998.
8. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir, PHI Course Pvt. Ltd. Publisher, 2008.

BPT402: Optics and Lasers (Credits: 2)

Course Objectives: Students should:

1. understand the concept of cardinal points, working of Searle's goniometer, optical magnifications, difference between resolving and magnifying powers.
2. study division of amplitude, division of wavefront, formation of interference in various films, Fresnel diffraction, Fraunhofer diffraction and a convex lens.
3. understand structure and types of optical fibers, principle and working of fiber optic communication system, working of some lasers and idea of Holography.
4. understand polarization principle, construction and working of polarimeter.

Unit-I: Geometrical optics (14)

Definition and properties of cardinal points of a lens system, coincidence of principal points and nodal points, Image formation by cardinal points, Newton's formula, relation between focal lengths of an optical system, axial, lateral and angular magnifications; Abbe's sine condition.

Resolving power

Resolving power, Rayleigh's criterion for the limit of resolution, comparison between magnifying power and resolving power, resolving power of plane diffraction grating, resolving power of prism.

Unit-II: Interference of light (14)

Principle of superposition of waves, Division of amplitude, division of wavefront, interference in thin parallel films due to reflected light, wedge shaped films, Newton's rings, its applications for determination of wavelength of light and R.I. of liquid.

Diffraction of light:

Types of diffraction, Fraunhofer diffraction: plane diffraction grating, theory of plane diffraction grating, its application to determine wavelength of monochromatic light, Fresnel diffraction: half period zones, zone plate, Fresnel diffraction at Narrow wire.

Unit-III: Polarization of light: **(10)**

Polarization by double refraction, Huygens explanation of double refraction through uniaxial crystals, optical rotation- laws of rotation of plane of polarization, polarimeter.

Unit IV: Laser system: **(7)**

Absorption, spontaneous and stimulated emission, Einstein coefficients (only definitions), population inversion, optical and electrical pumping, properties of lasers, Ruby laser, Helium-Neon laser, uses of laser, idea of holography(qualitative treatment only).

Course Outcomes:

Unit –I: After completion of the unit, **Students are able to:**

1. understand cardinal points, working of Searle's goniometer and optical magnifications
2. understand the idea of resolution, difference between resolving and magnifying powers.

Unit –II: After completion of the unit, **Students are able to:**

1. understand division of amplitude, division of wavefront and formation of interference in various films.
2. explain Fresnel diffraction, Fraunhofer diffraction, half period zones, zone plates and difference between zone plate and a convex lens.

Unit –III: After completion of the unit, **Students are able to:**

1. understand structure and types of optical fibers, principle and working of fiber optic communication system.
2. understand fundamental phenomenon in laser, Einstein's coefficients, and idea of holography.

Unit –IV: After completion of the unit, **Students are able to:**

1. understand double refraction, polarization and optical rotation
2. understand principle, construction and working of polarimeter.

REFERENCE BOOKS:

1. Geometrical and Physical Optics, R.S. Longhurst, Wiley Publisher, 2nd edition, 1967.
2. A Text Book of Optics, Brij Lal, M. N. Avadhanulu and N. Subrahmanyam, S. Chand Publisher, 25th edition, 2012.
3. Optics, Ajoy Ghatak, McGraw Hill Education India Pvt Ltd, 4th edition, 2008.
4. Laser and Non-linear optics, B. B. Laud, Wiley Publisher, 1991.
5. Physical optics and lasers, J. P. Agarwal, Pragati Prakashan, 13th edition, 2017.
6. Principles of Optics, B. K. Mathur, Gopala Printing, 1964.

7. Lasers, Fundamentals and Applications, K. Thyagarajan and Ajoy Ghatak, Springer Science and Business Media Publisher, 2nd edition, 2011.
8. Optics and Spectroscopy, R. Murugeshan and K. Sivaprasath, S. Chand Publisher, 10th edition, 1997.

BPP 403: Thermal Physics, Optics and Lasers
(Credits: 02)
Practical: 80 lectures, 64 hours

Course Objectives: Students should:

1. develop practical skills.
2. determine mechanical equivalent of heat, specific heat of solids and liquids.
3. study the laws of probability distribution, black body radiation.
4. study the cardinal points of an optical system.

Experiments:

Group - A

1. To determine Mechanical Equivalent of Heat J by Callendar and Barne's constant flow method.
2. To determine specific heat capacity of liquid by Callendar and Barne's constant flow method.
3. To determine Stefan's Constant.
4. Measurement of Planck's constant using black body radiation.
5. To verify the laws of Probability Distribution and to verify laws of probability of throwing one coin, two coins and then coins (or more).
6. The study of Statistical Distribution from the given data and to find most probable, average and rms values.
7. Specific Heat Capacity of Graphite and its variation with temperature.
8. Study of temperature coefficient of Thermistor.
9. To determine the ratio of specific heats of air by Kundt's tube.
10. Thermal conductivity of rubber tubing.

Group - B

1. Determination of dispersive power of material of prism.
2. Study of cardinal points by using Goniometer.
3. Determination of equivalent focal length of a system of lenses by using Goniometer.
4. Determination of R.I. of given liquid by Liquid Lens.
5. Determination of Cauchy's Constants.
6. Determination of specific rotation of sugar solution by using Polarimeter.

7. Determination of Resolving Power of plane diffraction grating.
8. Determination of wavelength of Sodium Light by Fresnel's Bi-prism.
9. Determination of Wavelength of sodium source by Newton's rings.
10. Determination of Wavelength of He-Ne Laser using grating.
11. Study of cardinal points by Newton's Method.

Course Outcomes:

Group A- After completion, Students are able to:

1. take measurements and readings with practical skills.
2. determine mechanical equivalent of heat, specific heat of solids and liquids.
3. study the laws of probability distribution, black body radiation.

Group B- After completion, Students are able to:

1. determine dispersive power, refractive index, resolving power of various materials, wavelengths of different sources by various methods.
2. plot the cardinal points of an optical system.

REFERENCE BOOKS:

1. Advanced Practical Physics for Students, B. L. Worsnop and H. T. Flint, Asia Pub. House, 9th edition, 1961.
2. Practical Physics, S. L. Gupta and V. Kumar, Pragati Prakashan, 27th edition, 2010.
3. An Advanced Course in Practical Physics, D. Chattopadhyay and P. C. Rakshit, New Central Book Agency Pvt. Ltd., 7th edition, 2005.
4. Experimental College Physics, White and Manning, McGraw-Hill Book Company, 3rd edition, 1954.
5. B.Sc. Practical Physics, H. Singh and P.S. Hemne, S. Chand Publisher, 4th edition, 2011.
6. B.Sc. Practical Physics, C. L. Arora, S. Chand Publisher, 1957.